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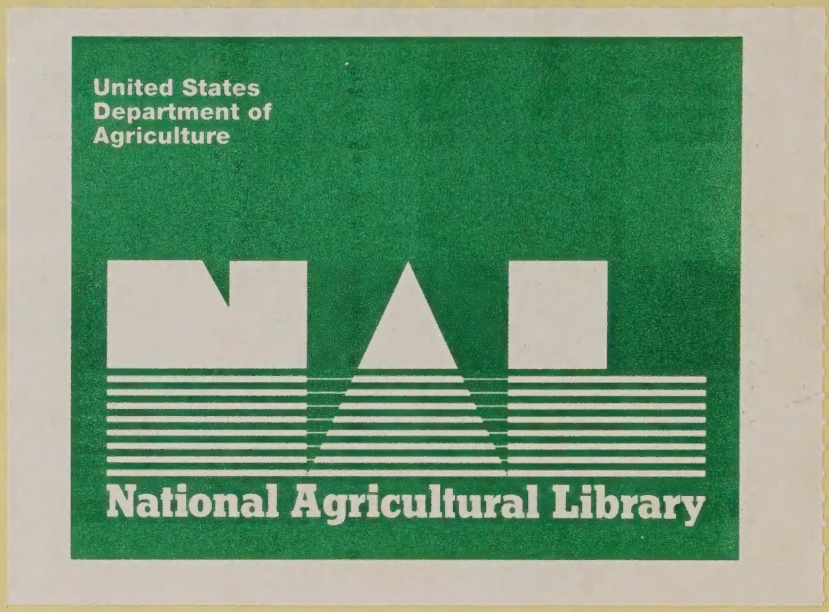
Pesticide Assessment of Field Corn and Soybeans: Northern Plains States

National Agricultural Pesticide Impact Assessment Program



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ABSTRACT

This report summarizes the pesticide assessment for corn and soybeans in the Northern Plains. Without insecticides, corn rootworm larvae and other soil insects would cause substantial corn yield losses. The loss of seed treatments would result in yield losses to both corn and soybeans. Among the herbicides, the loss of thiocarbamates would cause the greatest corn yield losses, while either dinitroanilines or triazines would cause the greatest soybean yield losses. This report includes pest rankings, estimates of acreages treated with pesticides or other pest management practices, and estimates of pest losses with and without pesticide use for insects, diseases, nematodes, and weeds.

Keywords: Corn, soybeans, pest losses, pest control, pesticide use, pesticide regulations

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INTRODUCTION

This report summarizes the field corn and soybean assessment for the Northern Plains States of Colorado, Kansas, Nebraska, North Dakota, and South Dakota. The estimates presented in this report are for the period 1978-82. Included are rankings of important pests in order of economic importance, pesticide use, estimates of acreages where major pesticides and other pest management practices are used, estimates of yield losses caused by pests with current practices, and estimates of losses when no pesticides are used. The estimates of losses are averaged for each State, but losses incurred by some producers will be significantly greater than the State or regional averages.

Land planted to field corn and soybeans constituted about 17 percent of the acreage used for crops (excluding pasture and idle land) in the Northern Plains States in 1978; field corn accounted for 14 percent and soybeans 3 percent. This region accounted for 17 percent of the U.S. corn acreage and 5 percent of the U.S. soybean acreage. The average area planted to corn during 1976-80 was 967,000 acres in Colorado, 1,938,000 in Kansas, 7,328,000 in Nebraska, 614,000 in North Dakota, and 3,284,000 in South Dakota. The average area planted to soybeans during this same period was 1,314,000 acres in Kansas, 1,375,000 in Nebraska, 185,000 in North Dakota, and 495,000 in South Dakota. The Northern Plains region produced approximately 16 percent of the corn and 5 percent of the soybeans in the United States from 1976 to 1980.

The pesticide assessment by commodity program, a cooperative effort of the State universities and the U.S. Department of Agriculture (USDA) under the National Agricultural Pesticide Impact Assessment Program (NAPIAP), is employed because required information does not exist or has not been assembled in a readily usable format. The program improves response to the Environmental Protection Agency (EPA) regulatory activity; provides information for Extension Service (ES) educational delivery systems; promotes information transfer among disciplines, regions, and States; identifies research needs and data gaps in pest control technology; and identifies emerging pest problems.

The procedure draws upon the knowledge of experts in entomology, nematology, plant pathology, weed science, animal damage control, and related sciences. These experts, in consultation with colleagues both within and among disciplines, were asked to draw upon research and demonstration plots, field experience, and pest control surveys to develop the information base. Concern is always expressed over compiling information not based completely on

replicated field trials or systematically planned use surveys. However, information based on such trials has not been, and likely will not be, forthcoming for most crops and pest problems. Thus, the combined experiences of the scientists involved forms the bases for the content of this report.

This regional pesticide assessment for field corn and soybeans represents an effort to estimate, in an orderly manner, yield losses and the effects of pesticide regulatory actions within the context of overall pest control practices. NAPIAP believes that this report and the underlying information base are useful for evaluating the effects of pesticide regulatory actions and the importance of pests. NAPIAP also believes that this report will contribute to future studies of this nature and indicate important areas for future research.

This report does not evaluate economic factors such as costs, crop prices, or pesticide price changes resulting from regulatory actions. It does not evaluate how pesticide price changes might influence pesticide use and crop losses. A future report will examine the effects of potential regulatory actions on costs and crop prices.

PROCEDURE FOR DATA COLLECTION

The NAPIAP State liaison representatives for each State identified the participating specialists. The Agricultural Research Service (ARS), USDA, and the Economic Research Service (ERS), USDA, provided facilitators to interview the participants.

The procedure followed several steps. All State specialists identified homogeneous production regions for corn and soybeans (equally subjected to pest problems, yield losses, and control practices). The specialists then estimated the percentage of field corn or soybeans planted under conventional, reduced, and no-till systems. Information was also included if irrigation significantly affected pest problems.

This report presents pest and pesticide information on insects, diseases, nematodes, and weeds. For each discipline, the 15 most important pest species were ranked for each production region, based on the acreage requiring treatment, the yield and quality losses, and the probability of recurrence. Pesticides applied were identified by active ingredient, timing of application, and percentage of planted acres treated in each production region. Target pests for each treatment were identified, and estimates of the proportion of planted acres treated for each were made. Also identified were nonchemical pest management practices, the target pests, and the percentage of planted acres treated.

Registered insecticides/acaricides and fungicides/nematicides were identified for each target pest and ranked by efficacy of yield. Pesticides with yield effects which were not significantly different received the same ranking.

Yield and percentage of planted acres were estimated where the pests in question caused no, low, medium, and high losses under current pest control practices used by growers. Yield and/or percentage of planted acreage were revised for each impact level by assuming that the most effective pesticide(s) is no longer available for use and that other pesticides and management practices can be used. This procedure continued by removing the second, then the third, and so forth, most effective pesticide(s) in succession while revising the yield and acreage estimates. Finally, estimates were made assuming no chemical pesticide

control was available for the pest in question. Separate estimates were made for tillage systems or production regions where impacts differed.

Herbicides were not ranked by efficacy. Estimates of the effect on yield of removing important herbicides and groups of herbicides such as triazines, thiocarbamates, or phenoxys were made. First, yield estimates were made for no, low, medium, and high losses resulting from all weeds and the percentage of planted acreage for each impact level for the current pattern of weed control practices. Then, a specific herbicide or group of herbicides was assumed unavailable for use. Resulting new weed problems and alternative control practices were identified, and estimates of yield and percentage of planted acres for each new impact level were made. Next, the first herbicide or group of herbicides was assumed available for use again, while a second herbicide or group of herbicides was assumed unavailable. Then the procedure was repeated. This process continued until the effects of removing each major herbicide and group were examined. Finally, changes in cultivation practices were identified and yield effects were estimated where herbicides were unavailable.

FIELD CORN

Tillage and Irrigation Systems

An estimated 20 percent of the acres planted to corn in the Northern Plains States was under conventional tillage, 35 percent under disc tillage, 41 percent under reduced tillage, and 4 percent under no-till. Disc tillage was used in Kansas and Nebraska (table 1). Depending upon the number of passes with the

Table 1. Corn acreage under major tillage and irrigation systems in the Northern Plains States 1/

Tillage and irrigation systems	Percentage of planted acres					
	CO	KS	NE	ND	SD	Region 2/
	Percent					
Conventional 3/	80	6	9	43	30	20
Disc tillage	-	35	58	-	-	35
Reduced 4/	20	59	25	54	70	41
No-till 5/	-	-	8	3	-	4
Irrigated	75	72	67	-	-	57
Nonirrigated	25	28	33	100	100	43

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ State estimates were weighted by planted acres to obtain regional estimates.
3/ Moldboard plowing, two passes with disc or cultivator before planting, one or more cultivations after planting.
4/ Chisel plow: one cultivation after crop emergence; or rotary tillage: disc stubble, roto-till and plant in one pass, one cultivation after crop emergence.
5/ No tillage operations before, during, or after planting.

disc, this tillage can be considered to be conventional or reduced in terms of surface residue. In Colorado, 80 percent was under conventional tillage. Of the total corn acreage in the region, 57 percent was irrigated and 43 percent was not irrigated. At least two thirds of the acreage planted to corn was irrigated in Colorado, Kansas, and Nebraska; almost none was irrigated in North and South Dakota.

Insects, Mites, Insecticides, Acaricides, and Losses

The most important corn insect pests in the Northern Plains States were western and northern corn rootworm larvae, European corn borers, and western bean cutworms (table 2). When ranked according to total acres, the corn rootworm adults of both species ranked the next most important economic pests. Mites, cutworms, and grasshoppers listed next in economic importance. Wireworms, chinch bugs, seed corn beetles, southwestern corn borers, armyworms, fall armyworms, white grubs, and corn earworms ranked in that order in only one or two of the States.

Regional ranking of insecticide use by acreage (table 3) showed that more acres were treated with fonofos (22 percent) than with other insecticides (except seed treatments). Some question exists with regard to the total acreage treated with seed treatments because the data did not differentiate between the various insecticides employed (lindane, diazinon, heptachlor, or toxaphene). Carbofuran was the next most widely used insecticide (19 percent) followed by phorate (13 percent), and chlorpyrifos (11 percent). Fewer acres were treated with terbufos (10 percent) and parathion (5 percent), and even fewer still with carbaryl, dimethoate, and permethrin (3 to 4 percent). Of the remaining insecticides, none were used on more than 2 percent of the total planted acres.

The favored insecticide used for corn rootworm control was fonofos, used on 18 percent of the planted acres. Carbofuran and phorate were used less frequently, in approximately equal amounts (13 percent). Fewer acres were treated with terbufos (10 percent), isofenfos (2 percent), and ethoprop (1 percent).

Corn borers were treated most frequently with carbofuran (6 percent), fonofos (4 percent), and permethrin (3 percent). Cutworms were treated almost exclusively with chlorpyrifos (8 percent), and considerably fewer acres were treated also with trichlorfon (less than 1 percent). Mites were treated most often with dimethoate (4 percent), while oxydemetonmethyl and propargite were used on almost equal numbers of acres (2 percent). Parathion was used less often. Considerable acreage was treated for undefined insects or insect complexes not specifically identified, which were most often treated with parathion (4 percent), carbaryl (4 percent), or chlorpyrifos (3 percent). Carbofuran, EPN, and toxaphene were used on fewer acres with almost equal frequency (1 percent each).

The most frequently used nonpesticide method of controlling corn rootworms in the Northern Plains was crop rotation, used on 22 percent of the acreage (table 4). Rotating less than 1 percent of the acreage helped control European corn borers, but early plantings (8 percent) were used more often to avoid such infestations. Fall tillage was practiced on 1 percent of the acres for controlling southwestern corn borers. Other related practices such as scouting, hybrid selection, and computerized infestation forecasts were performed on 54 percent of the planted acres.

The insect pest of the most serious consequence to corn was corn rootworm larvae. Corn rootworm larvae caused an estimated 3.8-percent yield loss, which could increase to 12.8 percent if no pesticides were used and rotations were not changed (table 5). However, two States reported that yield would increase if corn was rotated with soybeans and if pesticides were not used. European corn borers also damaged yields, causing an estimated 3.9-percent yield loss, which could increase to 7 percent if no pesticides were used. Mites and cutworms did not have such a significant yield-loss potential. Cutworms caused a 0.4-percent loss, which could increase to 1.3 percent without pesticides. Mites caused 0.9-percent losses, which could increase to 2.3 percent without pesticides. The remaining insects each had less than a 1-percent yield-loss potential.

Table 2. Ranking of corn insect and mite pests in the Northern Plains States 1/

Insects	Rank 2/					
	CO	KS	NE	ND	SD	Region
Western corn rootworms (larvae)	1	1	1	2	1	1
Northern corn rootworms (larvae)	NR	NR	1	2	1	2
European corn borers	3	3	2	5	2	3
Western bean cutworms	2	6	3	NR	NR	4
Western corn rootworms (adults)	9	NR	4	NR	4	5
Northern corn rootworms (adults)	NR	NR	4	NR	4	6
Mites	6	2	5	NR	NR	7
Cutworms	NR	4	6	4	3	8
Grasshoppers	5	7	NR	3	NR	9
Southwestern corn borers	10	5	NR	NR	NR	10
Wireworms	NR	NR	NR	1	NR	11
Seedcorn beetles	4	NR	NR	NR	NR	12
Chinch bugs	NR	9	7	NR	NR	13
Armyworms	8	8	NR	NR	NR	14
Fall armyworms	7	NR	NR	NR	NR	15
Corn earworms	10	NR	NR	NR	NR	16
White grubs	NR	NR	NR	6	NR	17

NR = Not reported.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ 1 = Most serious, 2 = second-most serious, etc. Regional rankings were weighted averages of State-level rankings. State-level rankings were uniformly standardized so each would have the same mean and variance. The standardized variables were weighted by planted acres to construct the regional ordering.

Table 3. Insecticide and acaricide use by timing and target pest in the Northern Plains States 1/

Active ingredients	Timing 2/	Target pest	Percentage of planted acres treated					
			CO	KS	NE	ND	SD	Region 3/
			Percent					
Carbaryl	8,10	Other	2	5	-	1	7	4
Carbofuran	3	Corn rootworms	21	12	13	3	15	13
Carbofuran	9,10	Corn borers	6	12	3	-	10	6
Carbofuran	3,9,10	Other	-	2	2	-	-	1
		Total	27	26	18	3	25	19
Chlorpyrifos	3,8	Cutworms	-	8	1	9	25	8
Chlorpyrifos	2,8	Other	-	7	4	-	-	3
		Total	-	15	8	9	25	11
Diazinon	3,8,10	Other	-	-	<1	1	-	<1
Dimethoate	10	Mites	14	13	2	-	-	4
Disulfoton	10	Mites	2	5	<1	1	-	2
Ethion	10	Mites	-	-	2	<1	-	<1
Ethoprop	3	Corn rootworms	3	-	2	-	-	1
EPN	10	Other	10	-	2	-	-	2
Fonofos	3	Corn rootworms	9	14	12	1	40	18
Fonofos	9,10	Corn borers	-	1	2	-	10	4
		Total	9	15	14	1	50	22
Isofenfos	3	Corn rootworms	9	8	2	1	-	3
Malathion	8	Grasshoppers	-	-	<1	2	-	<1
Methomyl	10	Cutworms	1	-	-	-	-	<1
Methyl parathion	3,8,9	Other	-	-	-	2	-	<1
Oxydemeton-methyl	10	Mites	-	13	<1	-	-	2
Parathion	10	Mites	14	-	<1	-	-	1
Parathion	10	Other	6	3	6	-	-	4
		Total	20	3	6	-	-	5
Permethrin	10	Corn borers	2	12	2	-	-	3
Phorate	3	Corn rootworms	9	13	7	5	30	13
Propargite	10	Mites	-	13	-	-	-	2
Terbufos	3	Corn rootworms	9	10	8	7	15	10
Toxaphene	8	Other	-	-	2	4	-	1
Trichlorfon	8	Cutworms	-	2	<1	-	-	<1
Diazinon, lindane, or heptachlor	ST	Seedcorn beetles and maggots	50	-	-	4	-	3

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ Timing of application, where:
ST = Seed treatment.
2 = In furrow at planting.
3 = At planting as a band.
8 = Postemergence foliar or over row.
9 = Postemergence whorl directed.
10 = Postemergence aerial.
3/ State estimates were weighted by planted acres to obtain regional estimates.

Table 4. Nonpesticide corn insect and mite management in the Northern Plains States 1/

Insects	Insect management practice	Percentage of planted acres				
		CO	KS	NE	ND	SD
		Percent				
Corn rootworms	Scouting 2/	44	28	3/7	2	-
	Rotation	-	5-10	20	30-35	40
European corn borers	Scouting 2/	44	29	3/7	2	-
	Hybrid selection	-	-	15	-	-
	Early planting	-	60	-	-	-
	Rotation	-	3	-	-	-
Mites	Scouting 2/	44	19	3/7	-	-
Southwestern corn borers	Scouting 2/	-	8	-	-	-
	Fall tillage	-	9-11	-	-	-
	Computer emergence prediction	-	9	-	-	-
Western bean cutworms	Scouting 2/	44	7	3/7	-	-
Other insects	Scouting 2/	-	-	3/7	2	7

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ Scouting is a pest detection practice which may lead to the use of pesticide or nonpesticide pest management practices.
3/ Nebraska reported 7 percent scouted for all pests.

Table 5. Average percentage corn insect and mite yield losses in the Northern Plains States 1/

Insects and insect control practices	Average percentage yield losses 2/					
	CO	KS	NE	ND	SD	Region 3/
			Percent			
Armyworms:						
Current controls	-	-	-	-	-	-
No pesticide controls	-	0.5	-	-	-	<0.1
Chinch bugs:						
Current controls	-	-	-	-	-	-
No pesticide controls	-	.2	-	-	-	<.1
Corn rootworm adults:						
Current controls	-	-	-	-	1.2	.3
No pesticide controls	-	-	-	-	2.0	.5
Corn rootworm larvae:						
Current controls	6	3.8	3.0	0.9	5.4	3.8
No pesticide controls (current cultivation)	22	20.2	11.8	4.1	9.4	12.8
No pesticide controls (crop rotation)	-	4/(11)	-	-	4/(10)	-
Cutworms:						
Current controls	-	.7	.2	.4	.8	.4
No pesticide controls	-	1.6	.5	9.2	2.0	1.3
European corn borers:						
Current controls	3.9	3.8	5.0	2.0	2.0	3.9
No pesticide controls	7.0	5.7	9.0	5.1	3.7	7.0
Grasshoppers:						
Current controls	.5	.4	-	1.1	-	.1
No pesticide controls	5/3.5	.6	-	11.0	-	.8
Mites:						
Current controls	1.9	1.9	1.0	-	-	.9
No pesticide controls	2.1	4.4	3.0	-	-	2.3
Southwestern corn borers:						
Current controls	-	1.1	-	-	-	.2
No pesticide controls	-	3.5	-	-	-	.5
Western bean cutworms:						
Current controls	5.1	-	-	-	-	.3
No pesticide controls	6.4	1.7	.1	-	-	.7
White grubs:						
Current controls	-	-	-	1.4	-	<.1
No pesticide controls	-	-	-	10.2	-	.4
Wireworms:						
Current controls	-	-	-	1.7	-	<.1
No pesticide controls	-	-	-	11.5	-	.5

- = Insignificant yield loss.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ These estimates were averaged over the entire planted corn acreage in each State. Estimates are losses from yields where the pest causes no perceptible damage.

3/ State estimates were weighted by planted acres to obtain regional estimates.

4/ Yield increase due to change to crop rotation.

5/ In most years, there was little acreage treated for grasshoppers. The figure reported is for years in which a serious outbreak would occur.

Diseases, Fungicides, Nematicides, and Losses

Table 6 lists diseases of field corn in the Northern Plains States by economic importance. The three most important diseases of field corn were stalk rots, of which the cited causal agents were *Fusarium moniliforme*, *Gibberella zeae*, and *Diplodia* spp. Charcoal rot ranked fourth, while ear and kernel rots ranked fifth. Other diseases of less importance in the Northern Plains States included: Goss' bacterial blight, seed rots and seedling blights, common smut, storage molds, head smut, northern and southern corn leaf blights, viruses, common corn rust, nematodes, southern rust, Stewart's wilt, and brown spot.

Almost all field corn acreage in Northern Plains States was planted with treated seed to prevent seed rots and seedling blights (table 7). However, 25 percent of the corn acreage in North Dakota was planted with carboxin-treated seed to control head smut. Captan-treated seed was planted on 76 percent of the acreage and thiram on 61 percent.

Table 6. Ranking of corn diseases and nematodes in the Northern Plains States 1/

Pests	Rank 2/ 3/				
	CO	KS	NE	ND	Region
Stalk rot (Fusarium)	1	1	1	NR	1
Stalk rot (Gibberella)	NR	1	1	1	2
Stalk rot (Diplodia)	NR	1	1	NR	3
Charcoal rot	NR	2	1	NR	4
Ear and kernel rots	3	8	2	2	5
Goss' bacterial blight and wilt	NR	NR	2	NR	6
Seed rots and seedling blights	NR	5	3	2	7
Common smut	2	4	4	1	8
Storage molds	5	12	3	NR	9
Head smut	NR	NR	3	3	10
Northern corn leaf blight	NR	NR	3	NR	11
Southern corn leaf blight	NR	NR	3	NR	12
Viruses	NR	3	4	NR	13
Common corn rust	4	9	4	NR	14
Nematodes	6	6	4	NR	15
Southern corn rust	4	10	4	NR	16
Stewart's wilt	NR	7	4	NR	17
Brown spot	NR	11	4	NR	18

NR = Not reported.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ No results provided by South Dakota.

3/ 1 = Most serious, 2 = second-most serious, etc. Regional rankings were weighted averages of State-level rankings. State-level rankings were uniformly standardized so each would have the same mean and variance. The standardized variables were weighted by planted acres to construct the regional ordering.

Table 7. Corn fungicide use in the Northern Plains States 1/

Active ingredients	Timing 2/	Target pest	Percentage of planted acres 3/				
			CO	KS	NE	ND	Region 4/
			Percent				
Captan	ST	Seed rots and seedling blights	20	90	80	75	76
Carboxin + thiram	ST	Seed rots, seedling blights, and head smut	-	-	-	25	1
Thiram	ST	Seed rots and seedling blights	80	-	80	-	61

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ Timing of application, where: ST = seed treatment.
3/ No results provided by South Dakota.
4/ State estimates were weighted by planted acres to obtain regional estimates.

Table 8 lists the significant nonchemical disease control methods used for field corn in the Northern Plains States. Resistant hybrids and population density control were the most frequently used methods. In Nebraska, the majority of the acreage was planted with hybrids resistant to northern and southern corn leaf blights. Ear rots were controlled by early harvest. Cultural methods such as ecofallow planting, crop rotation, early harvesting, balanced fertility, deep plowing, and irrigation controlled plant diseases on a relatively minor percentage of the Northern Plains States' acreage.

Seed rots and seedling diseases in the Northern Plains caused an estimated 2.3-percent yield loss to field corn with current controls (table 9). If fungicides were no longer available, losses would increase to 13 percent. Colorado reported that their yield losses from seed rots and seedling blights will escalate from 3 percent to 24 percent without pesticides. North Dakota losses would jump from less than 1 percent to 8 percent. Nebraska losses would increase from 3 percent to 15 percent. Kansas losses would increase from no loss to less than 2 percent.

Table 8. Nonpesticide corn disease management in the Northern Plains States 1/

Diseases	Disease management practices	Percentage of planted acres 2/			
		CO	KS	NE	ND
		Percent			
Charcoal rot	Avoid overplanting	-	-	80	-
	Ecofallow planting	-	-	5	-
Common smut	Crop rotation	-	-	95	95
	Resistant hybrid	-	-	5	1
Ear rots	Early harvest	-	30	90	-
	Harvest at less than 15-percent moisture	-	-	10	-
Northern corn leaf blight	Resistant hybrid	-	-	90	-
Southern corn leaf blight	Resistant hybrid	-	-	70	-
Stalk rot (Fusarium)	Adequate plant spacing	50	-	80	-
	Balanced fertility	50	50	50	-
	Crop rotation	60	-	40	95
	Deep plowing, chiseling	70	-	-	-
	Ecofallow planting	-	-	5	-
	Irrigate	-	25	-	-
	Resistant hybrid	5	-	10	95
Viruses	Resistant hybrid	-	75	-	-

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ No results provided by South Dakota.

Table 9. Average percentage corn yield losses from diseases controlled with pesticides in the Northern Plains States 1/

Diseases and disease control practices	Average percentage yield loss 2/ 3/				
	CO	KS	NE	ND	Region 4/
	Percent				
Seed rots and seedling blights:					
Current controls	3	-	3	0.4	2.3
No pesticide controls	24	1.6	15	8.0	13.0
Head smut:					
Current controls	-	-	-	.1	<.1
No pesticide controls	-	-	-	.4	<.1

- = Insignificant yield loss.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ These estimates were averaged over the entire planted acres in the State. Estimates are losses from yields where the pest causes no perceptible damage.
3/ No results provided by South Dakota.
4/ State estimates were weighted by planted acres to obtain regional estimates.

Green foxtail, redroot pigweed, yellow foxtail, velvetleaf, and shattercane ranked as the five most economically important corn weed pests in the Northern Plains States (table 10). Green foxtail ranked first in North Dakota, second in Nebraska, and fourth in Colorado and Kansas. Redroot pigweed was the most important weed in Colorado, shattercane in Kansas, velvetleaf in Nebraska,

Table 10. Ranking of corn weed pests in the Northern Plains States 1/

Weeds	Rank 2/ 3/				
	CO	KS	NE	ND	Region
Green foxtail	4	4	2	1	1
Redroot pigweed	1	5	3	3	2
Yellow foxtail	5	NR	2	1	3
Velvetleaf	NR	7	1	NR	4
Shattercane	11	1	4	NR	5
Grass sandbur	2	12	5	NR	6
Kochia	3	11	9	2	7
Volunteer corn	NR	NR	6	NR	8
Wild sunflower	7	14	8	10	9
Cocklebur	NR	NR	7	NR	10
Barnyard grass	14	3	10	NR	11
Crabgrass	NR	2	11	NR	12
Lambsquarters	6	NR	13	8	13
Hemp dogbane	NR	NR	12	NR	14
Smooth pigweed	NR	6	NR	NR	15
Smartweed	NR	NR	14	NR	16
Fall panicum	NR	10	15	NR	17
Canada thistle	8	NR	NR	7	18
Giant foxtail	NR	8	NR	NR	19
Johnsongrass	NR	9	NR	NR	20
Wild oats	NR	NR	NR	4	21
Wild mustard	NR	NR	NR	5	22
Quackgrass	NR	NR	NR	6	23
Purslane	9	NR	NR	NR	24
Proso millet	12	NR	NR	9	25
Hairy nightshade	10	NR	NR	NR	26
Field bindweed	13	NR	NR	NR	27
Milkweed, climbing	NR	13	NR	NR	28
Black mustard	15	NR	NR	NR	29

NR = Not reported.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ No results provided by South Dakota.

3/ 1 = Most serious, 2 = second-most serious, etc. Regional rankings were weighted averages of State-level rankings. State-level rankings were uniformly standardized so each would have the same mean and variance. The standardized variables were weighted by planted acres to construct the regional ordering.

and yellow foxtail in North Dakota. Only green foxtail, redroot pigweed, kochia, and wild sunflower were identified by all States.

The three most widely used herbicides in the Northern Plains were atrazine, alachlor, and butylate, used on approximately 54 percent, 27 percent, and 18 percent of the acreage, respectively (table 11). Also important were 2,4-D, used on about 14 percent of the acreage; cyanazine on 13 percent; EPTC on 7 percent; and dicamba on 3 percent. Important nonpesticide weed management practices included rotation to control shattercane on 37 percent of the acreage and scouting on 13 percent (table 12). The practices used and the acreage on which they were used varied among States.

Weeds caused an estimated 3.8-percent yield loss in the Northern Plains (table 13). If atrazine and all other triazines were no longer available, losses would increase to approximately 5 percent, with the greatest increase in losses in North Dakota. If either 2,4-D, dicamba, or cyanazine were not available, losses would increase slightly. Losses were greater when groups of herbicides were removed from use. If no thiocarbamates were available for use, weed losses would increase to almost 9 percent, with the losses concentrated in Kansas and Nebraska. If no acetanilides were available, losses would increase to 5.5 percent, concentrated entirely in Kansas. If no herbicides were available, yield loss would be much greater, increasing to about 21 percent with current cultivation and to 12 percent with increased cultivation.

Table 11. Corn herbicide use in the Northern Plains States 1/

Active ingredients	Percentage of planted acres 2/ 3/				
	CO	KS	NE	ND	Region 4/
			Percent		
Alachlor	20	15	31	25	27
Atrazine	31	77	55	12	54
Butylate + safener	15	16	20	2	18
Cyanazine	25	7	12	25	13
Diallate	-	-	-	1	<1
Dicamba	4	1	3	5	3
EPTC + safener	18	19	2	10	7
Metolachlor	14	1	1	5	2
Pendimethalin	-	-	-	2	<1
Propachlor	-	3	1	1	1
2,4-D	65	4	11	5	14

- = Insignificant acreage treated.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ Estimates included acres treated by individual herbicides or in tank mixes. Hence, there was double counting of acres treated with tank mixes.
3/ No results provided by South Dakota.
4/ State estimates were weighted by planted acres to obtain regional estimates.

Table 12. Nonpesticide weed management in the Northern Plains States 1/

Weeds	Weed management practice	Percentage of planted acres 2/			
		CO	KS	NE	ND
		Percent			
Foxtails	Fall plowing	-	-	-	10
Johnsongrass	Rotation	-	15-20	-	-
Shattercane	Rotation	-	15-20	50	-
Wild oats	Delayed planting	-	-	-	20
All weeds	Scouting 3/	50	30-35	-	1

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ No results provided by South Dakota.
3/ Scouting is a pest detection practice which may lead to the use of pesticide or nonpesticide pest management practices.

Table 13. Average percentage corn weed yield losses in the Northern Plains States 1/

Weed control practice	Average percentage yield loss 2/ 3/			
	KS	NE	ND	Region 4/
	Percent			
Current controls	3.2	3.6	8.6	3.8
Remove:				
Atrazine	6.5	3.6	15.1	4.9
Butylate	3.2	3.6	8.6	3.8
Cyanazine	3.8	3.6	8.6	3.9
Dicamba	3.2	3.6	16.5	4.3
EPTC	3.2	3.6	8.6	3.8
Paraquat	3.2	3.6	8.6	3.8
Pendimethalin	3.2	3.6	8.6	3.8
Propachlor	3.2	3.6	8.6	3.8
2,4-D	3.2	3.6	16.5	4.3
Acetanilides	11.8	3.6	8.6	5.5
Thiocarbamates	11.8	7.7	8.6	8.6
Triazines	6.5	3.6	15.1	4.9
No chemical controls:				
Extra cultivation	18.0	9.5	18.0	11.7
Current cultivation	40.0	16.0	26.3	21.3

1/ Corn and Soybean Assessment, NAPIAP, USDA.
2/ These estimates are average yield losses over the entire planted acreage in the State from a maximum where weeds cause no perceptible loss.
3/ No results provided from Colorado and South Dakota.
4/ State estimates were weighted by planted acres to obtain regional estimates.

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SOYBEANS

Tillage and Irrigation Systems

An estimated 22 percent of the soybean acreage in the Northern Plains States was under conventional tillage, 39 percent under disc tillage, and 39 percent under reduced tillage (table 14). The major systems in Kansas and Nebraska were disc tillage and reduced tillage, while conventional tillage was the major system in North and South Dakota. Depending upon the number of passes with a disc, disc tillage can be either conventional or reduced in terms of surface residue. Soybeans generally were not irrigated in the Northern Plains States.

Insects, Insecticides, and Losses

There were no insecticide treatments or significant insect yield losses reported in the Northern Plains States. However, the situation varies by year and State. In some years, insecticides may be needed to prevent soybean yield losses. Insects affecting soybeans are ranked in table 15.

Table 14. Soybean acreage under major tillage systems in the Northern Plains States 1/

Tillage systems	Percentage of planted acres				
	KS	NE	ND	SD	Region 2/
	Percent				
Conventional 3/	14	10	63	60	22
Disc tillage	33	64	0	0	39
Reduced 4/	53	25	37	40	39
No-till 5/	0	1	0	0	<1

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ State estimates were weighted by planted acres to obtain regional estimates.
3/ Moldboard plowing, two passes with disc or cultivator before planting, one or more cultivations after planting.
4/ Chisel plowing: chisel plow, one cultivation after crop emergence; or rotary tillage: disc stubble, roto-till and plant in one pass, two cultivations after crop emergence.
5/ No tillage operations before, during, or after planting.

Table 15. Ranking of soybean insect pests in the Northern Plains States 1/

Insects	Rank 2/ 3/		
	KS	NE	SD
Bean leaf beetles	2	*	NR
Corn earworms	3	NR	NR
Green cloverworms	1	*	NR
Mexican bean beetles	NR	NR	1
Soil cutworms	NR	*	NR

NR = Not reported.
* = Identified but not ranked.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ No results provided by North Dakota; insignificant soybean acreage in Colorado.
3/ 1 = Most important, 2 = second-most important, etc.

Diseases, Fungicides, Nematicides, and Losses

Table 16 lists soybean diseases in the Northern Plains by economic importance. Soilborne pathogens caused diseases of the greatest importance. The six most important soybean diseases in the Northern Plains were Phytopthora rot, seed rots and damping-off, charcoal rot, pod and stem blight, and stem canker. Diseases of less importance included fusarium root rot, bacterial diseases (bacterial blight and bacterial pustule), foliar fungal diseases (downy mildew, pod and stem blight, stem canker, Sclerotinia stem rot, and brown spot), and viruses.

Pesticides were used for the control of soybean diseases to a very limited degree (table 17). Seed rots and damping-off were the only diseases for which any chemical control was attempted, and these seed treatments were used on only 8 percent of the planted acreage. Yield losses from these diseases would increase from 4.8 percent with current controls to 7.2 percent with no pesticide controls (table 18). Nebraska was the only State to estimate significant losses from damping-off.

Nonpesticide soybean disease management practices played an important role, especially in Nebraska where 100 percent of the acreage was planted with certified seed to avoid damage from damping-off, Fusarium root rot, and Phytophthora rot (table 19). Kansas and Nebraska planted resistant varieties on 25 percent of their soybean acreage to control Phytopthora rot. Adjusting the planting rate managed charcoal rot on 30 percent of the acreage in Kansas and 75 percent in Nebraska. North and South Dakota did not report significant nonpesticide soybean disease management practices.

Table 16. Ranking of soybean disease pests in the Northern Plains States 1/

Diseases	Rank 2/ 3/			
	KS	NE	ND	Region
Phytopthora rot	2	1	NR	1
Seed rots and damping-off	3	2	2	2
Charcoal rot	1	3	NR	3
Pod and stem blight	4	3	4	4
Stem canker	4	3	NR	5
Rhizoctonia root and stem rot	NR	2	1	6
Fusarium root rot	NR	2	3	7
Bacterial blight	4	4	2	8
Viruses	5	3	NR	9
Downy mildew	4	4	3	10
Bacterial pustule	4	4	NR	11
Brown spot	NR	4	4	12
Sclerotinia stem rot	NR	NR	2	13

NR = Not reported.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ No results provided by South Dakota; no signficiant acreage in Colorado.
3/ 1 = Most serious, 2 = second-most serious, etc. Regional rankings were weighted averages of State-level rankings. State-level rankings were uniformly standardized so each would have the same mean and variance. The standardized variables were weighted by planted acres to construct the regional ordering.

Table 17. Soybean fungicide use in the Northern Plains States 1/

Active ingredients	Timing 2/	Target pest	Percentage of acres treated 3/			
			KS	NE	ND	Region 4/
			Percent			
Captan	ST	Seed rots and damping-off	5	3	4	4
Carboxin	ST	do.	1	-	1	<1
ETMT + PCNB	ST	do.	-	2	-	1
Thiram	ST	do.	5	-	1	2

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ Timing of application, where: ST = seed treatment.
3/ No results provided by South Dakota; insignificant soybean acreage in Colorado.
4/ State estimates were weighted by planted acres to obtain regional estimates.

Table 18. Average percentage soybean disease yield losses in the Northern Plains States 1/

Diseases and disease control practices	Average percentage yield loss 2/ 3/			
	KS	NE	ND	Region 4/
		Percent		
Seed rots and damping-off:				
Current controls	-	10	-	4.8
No pesticide controls	-	15	-	7.2

- = Insignificant yield losses.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ These estimates were averaged over the entire planted acres in each State. Estimates are losses from yields where the pest causes no perceptible damage.
3/ No results provided by South Dakota; insignificant soybean acreage in Colorado.
4/ State estimates were weighted by planted acres to obtain regional estimates.

Table 19. Nonpesticide soybean disease management in the Northern Plains States 1/

Diseases	Disease management practice	Percentage of planted acres 2/		
		KS	NE	ND
			Percent	
Charcoal rot	Correct planting rate	30	75	-
	Irrigation	5	-	-
Damping-off	Seed certified for quality	-	100	-
Fusarium root rot	do.	-	100	-
Phytopthora rot	do.	-	100	-
	Resistant variety	25	25	-
Other diseases	Rotation	-	-	<1

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ No results provided by South Dakota; insignificant soybean acreage in Colorado.

Weeds, Herbicides, and Losses

Shattercane, velvetleaf, redroot pigweed, green foxtail, and giant foxtail were the five most important soybean weed pests in the Northern Plains States (table 20). Shattercane ranked first in Kansas and Nebraska. Velvetleaf also ranked first in Nebraska, while green foxtail and yellow foxtail received that ranking in North Dakota. Only redroot pigweed, green foxtail, volunteer corn, and wild sunflower were identified by all three States.

The three most widely used herbicides were trifluralin, alachlor, and metribuzin (table 21). Trifluralin was applied to 55 percent of the acreage,

Table 20. Ranking of soybean weed pests in the Northern Plains States 1/

Weeds	Rank 2/ 3/			
	KS	NE	ND	Region
Shattercane	1	1	NR	1
Velvetleaf	2	1	NR	2
Redroot pigweed	3	2	5	3
Green foxtail	6	2	1	4
Giant foxtail	7	2	NR	5
Smooth pigweed	4	NR	NR	6
Cocklebur	9	3	NR	7
Hairy crabgrass	5	NR	NR	8
Volunteer corn	12	3	10	9
Sunflower	13	3	11	10
Annual morningglory	8	NR	NR	11
Ivyleaf morningglory	10	NR	NR	12
Johnsongrass	11	NR	NR	13
Barnyardgrass	14	NR	NR	14
Yellow foxtail	NR	NR	1	15
Wild mustard	NR	NR	2	16
Fall panicum	15	NR	NR	17
Wild oats	NR	NR	3	18
Kochia	NR	NR	4	19
Canada thistle	NR	NR	6	20
Lambsquarters	NR	NR	7	21
Devilsclaw	16	NR	NR	22
Quackgrass	NR	NR	8	23
Black nightshade	NR	NR	9	24
Smartweed	NR	NR	12	25

NR = Not reported.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ No results provided by South Dakota; an insignificant soybean acreage in Colorado.
3/ 1 = Most serious, 2 = second-most serious, etc. Regional rankings were weighted averages of State-level rankings. State-level rankings were uniformly standardized so each would have the same mean and variance. The standardized variables were weighted by planted acres to construct the regional ordering.

alachlor to 32 percent, and metribuzin to 34 percent. Much less important were bentazon, applied to 7 percent of the acreage; linuron to 5 percent; pendimethalin to 4 percent; and chloramben to 3 percent. Important nonpesticide management practices reported were hand rogueing in Nebraska to control all weeds and changing crop sequence in Kansas to control broadleaf weeds (table 22).

Weeds caused an estimated 5-percent soybean yield loss in the Northern Plains (table 23). If metribuzin were no longer available, weed losses would increase to about 15 percent in the region, the greatest impact of all herbicides. If trifluralin were removed from use, losses would increase to about 10 percent. Removing acifluorfen, bentazon, or glyphosate would cause small increases in yield losses. If no triazines or no dinitroanilines were available, yield losses would increase to approximately 15 percent. If no herbicides were available, losses would be much greater, increasing to about 18 percent with extra cultivation and 29 percent with current cultivation.

Table 21. Soybean herbicide use in the Northern Plains States 1/

Active ingredients	Percentage of planted acreage 2/ 3/			
	KS	NE	ND	Region 4/
	Percent			
Acifluorfen	-	1	2	<1
Alachlor	33	33	10	32
Bifenox	1	-	-	<1
Bentazon	10	3	15	7
Chloramben	4	1	15	3
Diallate	-	-	2	<1
Diclofop	-	-	8	<1
Glyphosate	-	8	-	4
Linuron	8	3	-	5
Metolachlor	-	-	5	<1
Metribuzin	29	41	10	34
Naptalam + dinoseb	-	-	5	<1
Oryzalin	2	-	-	<1
Pendimethalin	8	1	5	4
Trifluralin	62	47	70	55

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ Estimates include acres treated both individually or in tank mixes. Hence, there was double counting of acres treated with tank mixes.
3/ No results provided by South Dakota; insignificant soybean acreage in Colorado.
4/ State estimates were weighted by planted acres to obtain regional estimates.

Table 22. Nonpesticide soybean weed management in the Northern Plains States 1/

Weeds	Weed management practice	Percentage of planted acres 2/		
		KS	NE	ND
		Percent		
Black nightshade	Monitor seed source	-	-	<2
Wild mustard	Delayed planting	-	-	10
Wild oats	Delayed planting	-	-	5
Broadleaf weeds (especially velvetleaf)	Change cropping sequence	5-15	-	-
All weeds	Hand roqueing	15	40	-

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ No results provided by South Dakota; an insignificant soybean acreage in Colorado.

Table 23. Average percentage soybean weed yield losses in the Northern Plains States 1/

Weed control practices	Average percentage yield loss 2/ 3/			
	KS	NE	ND	Region 4/
	Percent			
Current controls	3.0	7.0	5.2	5.1
Remove:				
Acifluorfen	3.0	7.5	7.0	5.3
Bentazon	3.0	8.0	5.2	5.5
Chloramben	3.0	7.0	5.2	5.1
Glyphosate	3.5	9.0	7.0	6.3
Linuron	3.0	7.0	7.0	5.2
Metribuzin	13.5	17.0	5.2	14.6
Paraquat	3.0	7.0	7.0	5.2
Pendimethalin	3.0	7.0	7.0	5.2
Trifluralin	3.0	17.0	7.0	10.0
Vernolate	3.0	7.0	7.0	5.2
Acetanilides	3.0	7.0	5.2	5.1
Dinitroanilines	13.5	17.0	7.0	14.7
Triazines	13.5	17.0	5.2	14.6
No chemical controls:				
Extra cultivation	18.0	17.3	16.4	17.6
Current cultivation	40.3	19.5	24.0	29.2

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ These estimates are yield losses over the entire planted acreage in the State from a maximum where weeds cause no perceptible loss.
3/ No results provided by South Dakota; insignificant soybean acreage in Colorado.
4/ State estimates were weighted by planted acres to obtain regional estimates.

RESEARCH AND DATA NEEDS

The field corn and soybean pesticide assessment reveals several important research needs. First, State and Federal pesticide use surveys should continue in order to provide current information. The surveys should identify major target pests for pesticide treatments. These surveys need to identify the relative importance of nonpesticide pest management practices. There are variabilities in the practices identified and the estimates of use between States. Therefore, State pest control experts should develop standardized definitions of practices and identify practices to be included in survey questionnaires.

Second, there should be more empirical field research concerning pest damage to crop yield and quality because satisfactory baseline data do not exist for many economic analyses. Existing projects which estimate pest damage under various circumstances should be expanded to include how pests interact to damage crops and how additional factors such as climate influence crop damage and quality. Research should also estimate the extent of various degrees of yield and quality damage.

These needs might be accomplished by sampling farmers' fields over a number of years to estimate pest infestations and their effect on yield and quality. With such studies, researchers could project the likelihood of various degrees of pest damage. Such research would provide a stronger basis for estimating the economic effects of potential regulatory actions and the production effects of new and improving technologies.